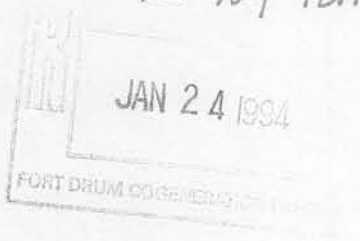

LARVAL FISH ENTRAINMENT AT THE FORT DRUM HTW CONGENERATION FACILITY FORT DRUM, NEW YORK

Prepared for

Fort Drum Cogeneration Partners
P.O. Box 330
Fort Drum, New York 13603

Prepared by

William H. Burton

Versar, Inc.
9200 Rumsey Road
Columbia, Maryland 21045

October 1993

FOREWORD

This report was prepared by Versar, Inc. for the Fort Drum Cogeneration Partners under the direction of Mr. Drew German. This research was conducted at the request of the New York State Department of Environmental Conservation. Field sampling was conducted by Jefferson Community College students Michael Kaban, Brent Bevan, Ruthie Kratz, Scott Kreager, and Wanda LaCelle. Mark Fenlon, biology professor -- Jefferson Community College, provided scheduling and technical support during the research program.

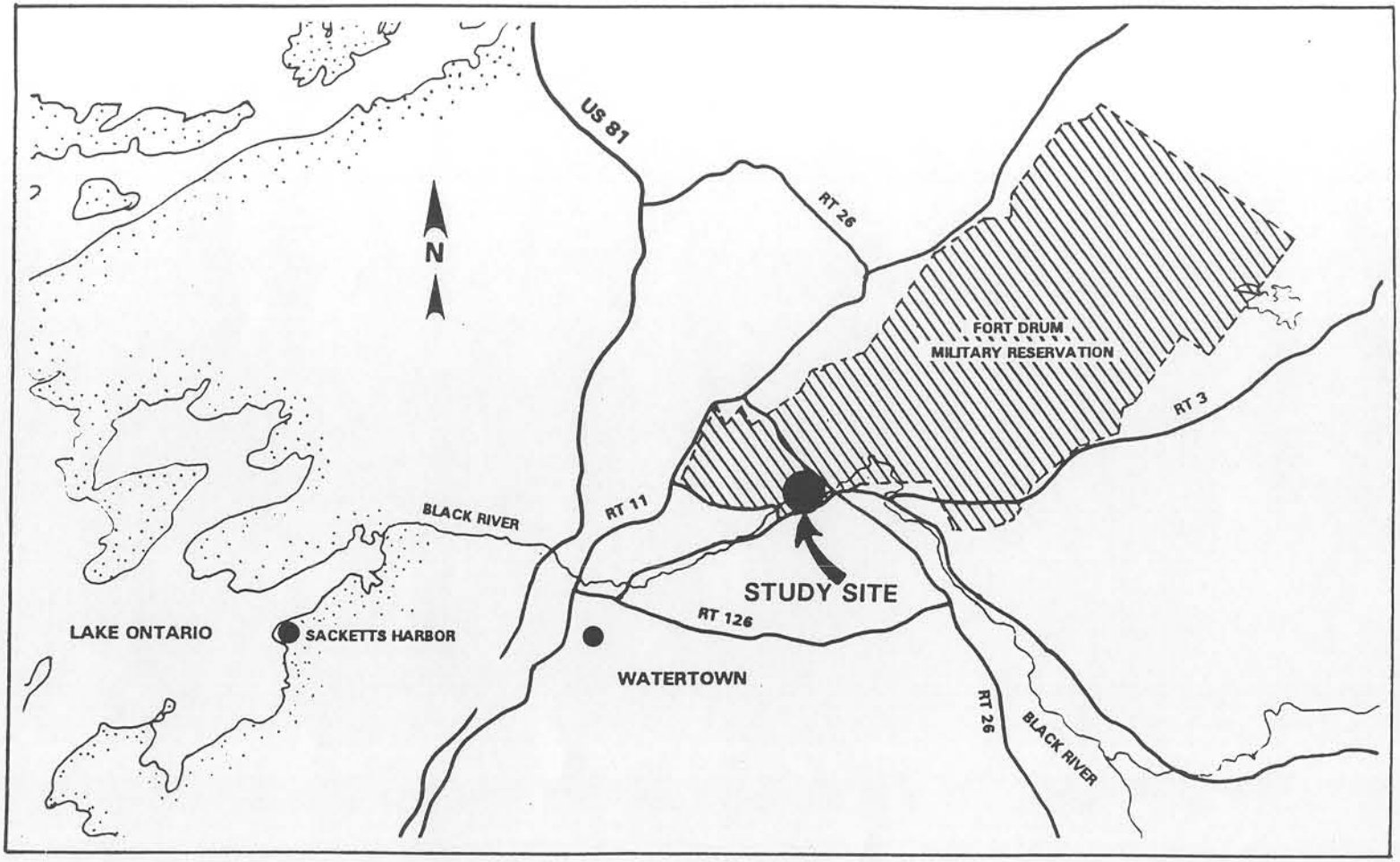

Figure 1-1. Location of the Fort Drum HTW Cogeneration Facility in relationship to the Army Base, the Black River, and Watertown, New York

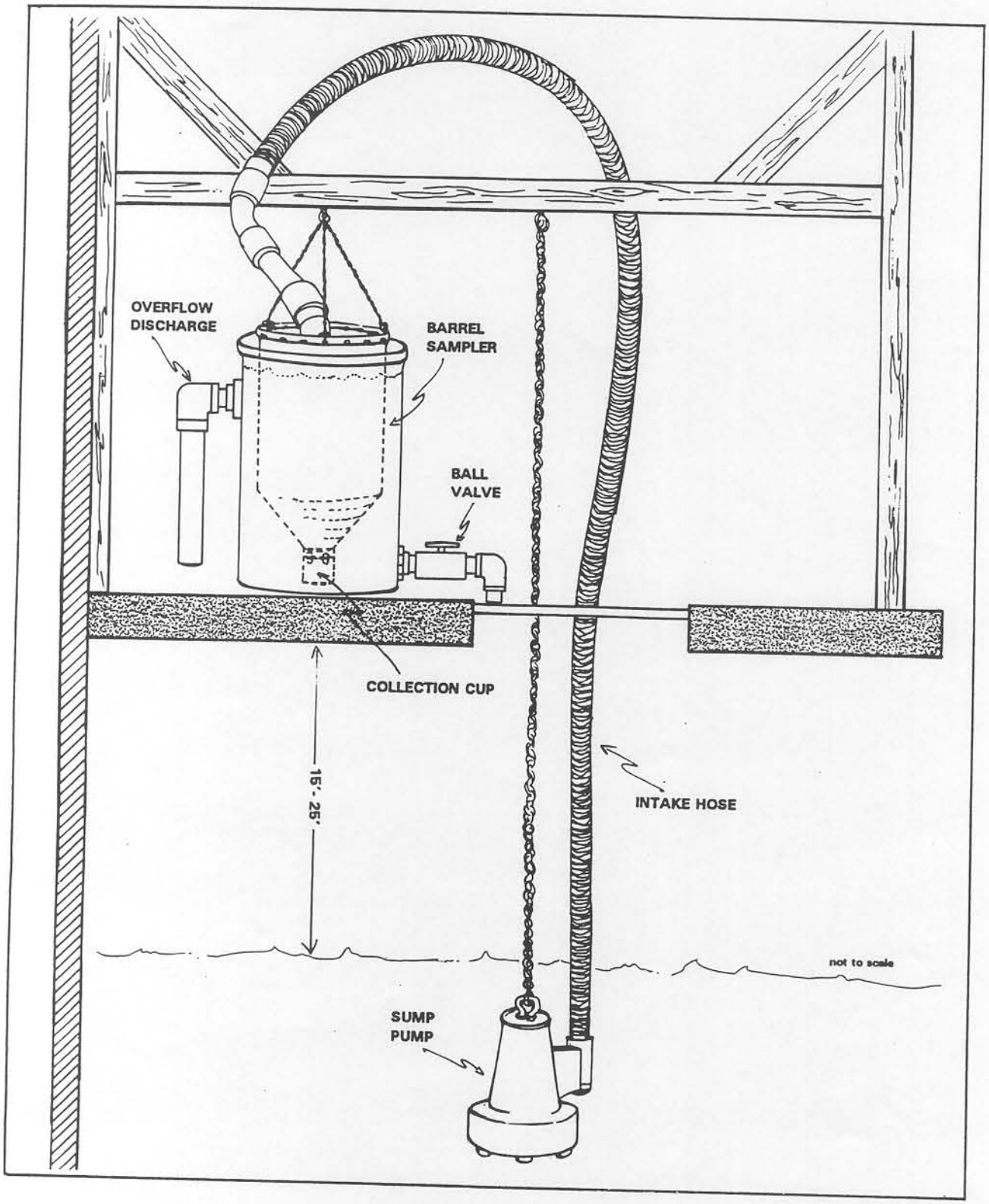

Figure 2-2 Schematic of the barrel sampler used for the Fort Drum HTW Cogeneration Facility entrainment study

2.3 DATA ANALYSIS

Daily average densities (number/1,000 cubic meters) of each species collected during the entrainment study were calculated by summing the total number collected during the 24-hr period and dividing by the total volume of water filtered by the barrel sampler, using the following formula:

$$D = \frac{C}{V}$$

where:

D = average daily density for each species
C = total number of each species found in each 24-hr sample
V = total volume of water filtered through the barrel sampler in the 24-hr sample period

Adjustments for collection efficiency of the plankton net and sump pump were not included in the calculations of species density.

Weekly entrainment rate was estimated by multiplying the average daily water volume pumped through the plant for each week by species density, and multiplying that by seven to obtain an estimate for the entire week. The formula used for calculating the weekly entrainment rate is expressed as follows:

$$W = (D \times F) \times 7$$

where:

W = weekly entrainment rate for each species
F = total daily flow through the plant

3.0 RESULTS AND DISCUSSION

3.1 FLOW RATES AND PHYSICAL MEASUREMENTS

The flow rates through the Fort Drum HTW Cogeneration facility during the 25-week study period averaged around 32,000 gpm (Fig. 3-1). Reductions in flow through the facility occurred during April due to a reduction in the number of circulators used (Table 2-1) and because the screens became clogged with debris during the onset of the spring thaw. Average flows were lowest during the third week in July (6,408 gpm) as a result of a planned plant outage, when only 1 circulation pump was running.

To place the flow rates through the facility in perspective to the flows within the Black River, average monthly flow rate was compared to the mean river discharge as measured at the nearest USGS gauging station, nine miles downstream at Watertown, New York between 1988 and 1992. This comparison revealed that, on the average, the Cogeneration plant uses from as little as 0.8% of the water flowing past the facility during high discharge periods to as high as 4.3% during seasons with low flows (Table 3-1).

Weekly measurement of temperature revealed that temperature ranged from a low of 0.9° C during the first week of the study to about 22° C during the last three weeks in August (Fig. 3-2). Measurements of pH indicated that the river water was slightly acidic, which was expected due to the presence of tannic acid within the Black River. Dissolved oxygen was at or above saturation and displayed a typical pattern of higher levels during colder months (when the water is colder and can hold more oxygen) to lower levels in the warmer months.

3.2 ENTRAINMENT OF ICHTHYOPLANKTON

The total entrainment of fish eggs and larvae through the facility during the 25-week sampling period was extremely low. No fish were found in any of the samples collected during the first 11 weeks (5 March through 14 May), and in more than 10 million gallons of water filtered only 36 larval fish were collected (Table 3-2). No fish eggs were found in any of the entrainment samples. The few larvae that were collected represented six families including suckers, sunfishes, catfishes, minnows, darters, and trout-perches. Of these, rock bass (*Ambloplites rupestris*) was the most abundant species constituting 33% of the total catch and occurring principally in July (weeks 18 through 21, Fig. 3-3). Catfish larvae constituted 27% of the total catch and were present in the collections from 9 July (week 19) through the last sample week on 20 August (catfish could not be identified to species reliably due to the very early life stages of the specimens). Members of the sucker family were the earliest species found in the samples. Suckers were present in the 21 May (week 12) through the 18 June (week 16) collections and constituted 25% of the total catch. Damage of the specimens and limitations on the taxonomy of early stages made identification to species unreliable, but the suckers collected during the study were probably either the white sucker (*Catostomus commersoni*) or the longnose sucker (*Catostomus catostomus*). During week 14 (4 June), one specimen of an identified minnow and darter were found, which together constituted only 2.7% of the total catch.

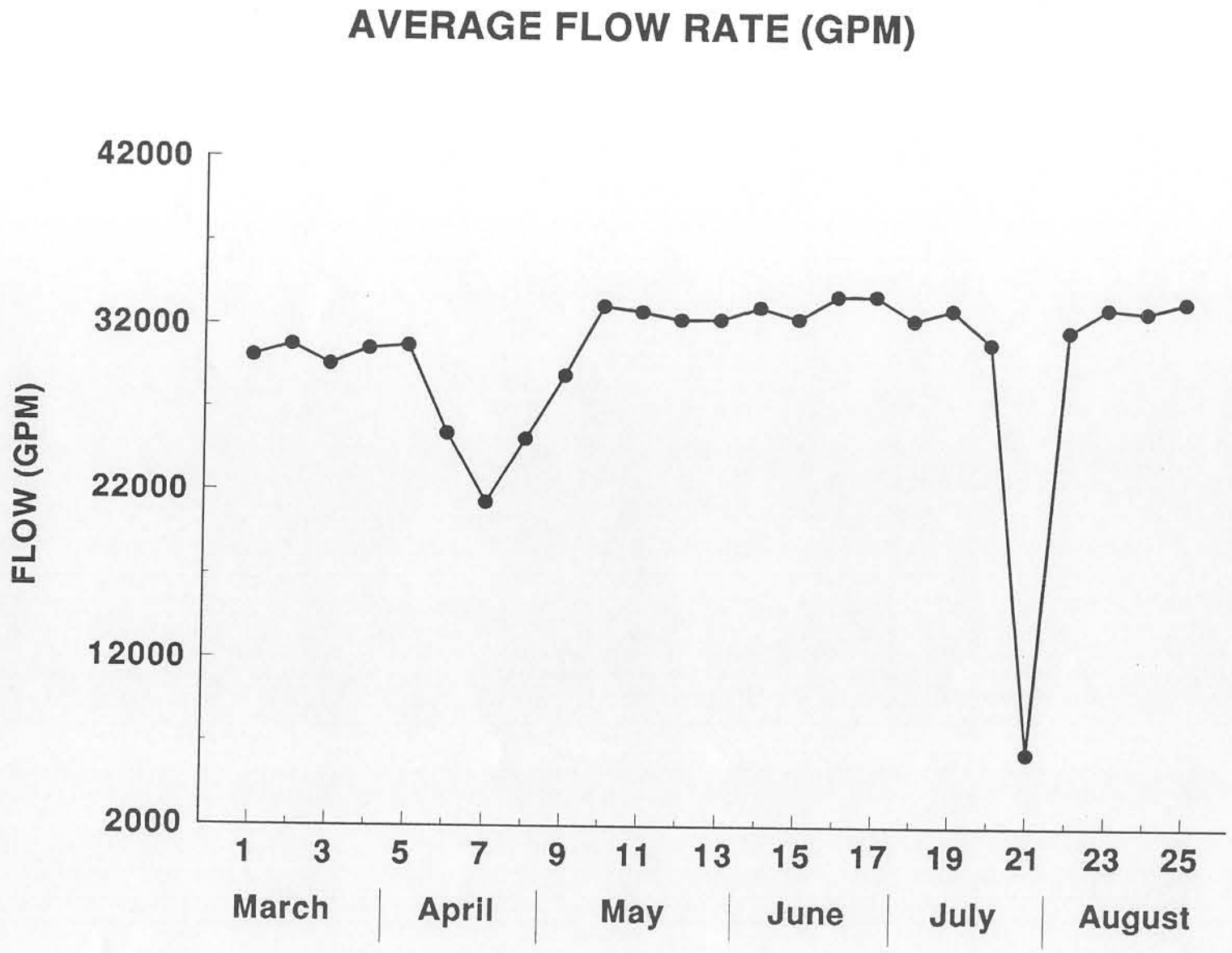

Figure 3-1. Average weekly flow rate through the Fort Drum HTW Cogeneration Facility during the 1993 entrainment study

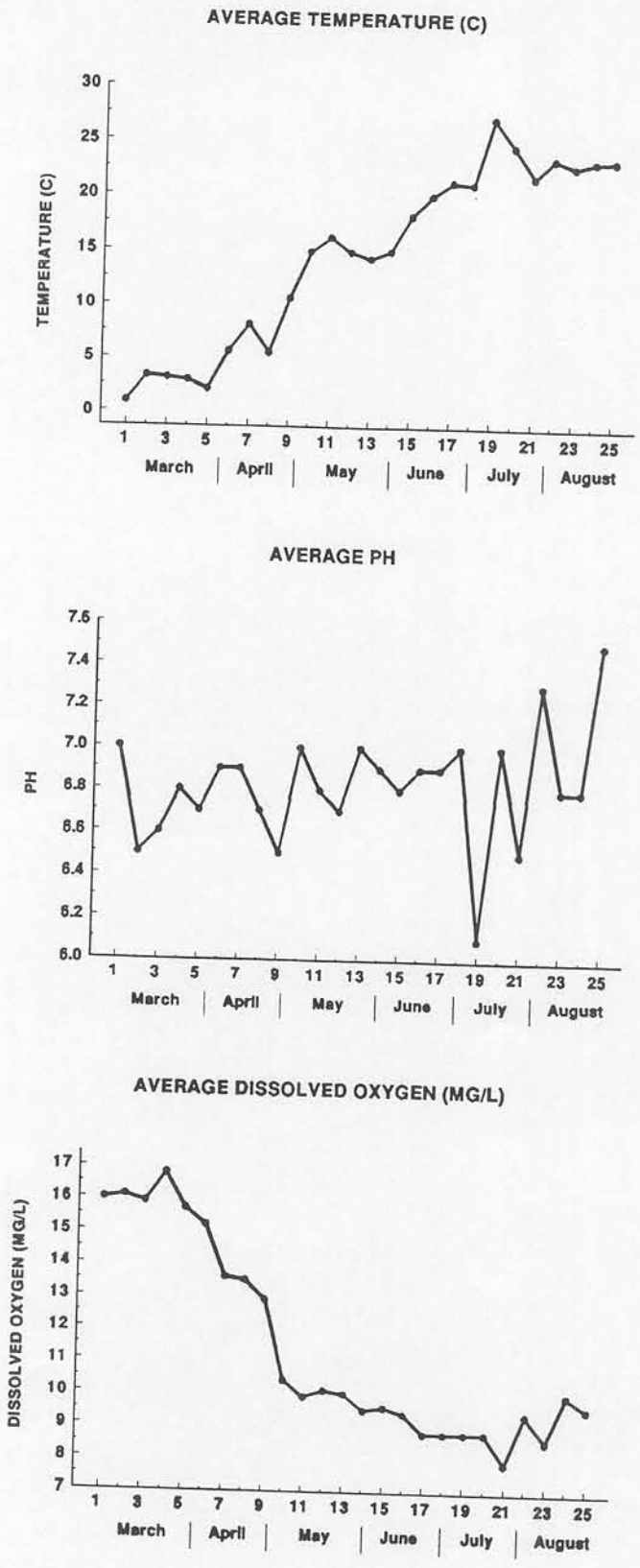

Figure 3-2. Mean temperature, pH, and dissolved oxygen (mg/l) at the intake well during the 1993 entrainment study at Fort Drum

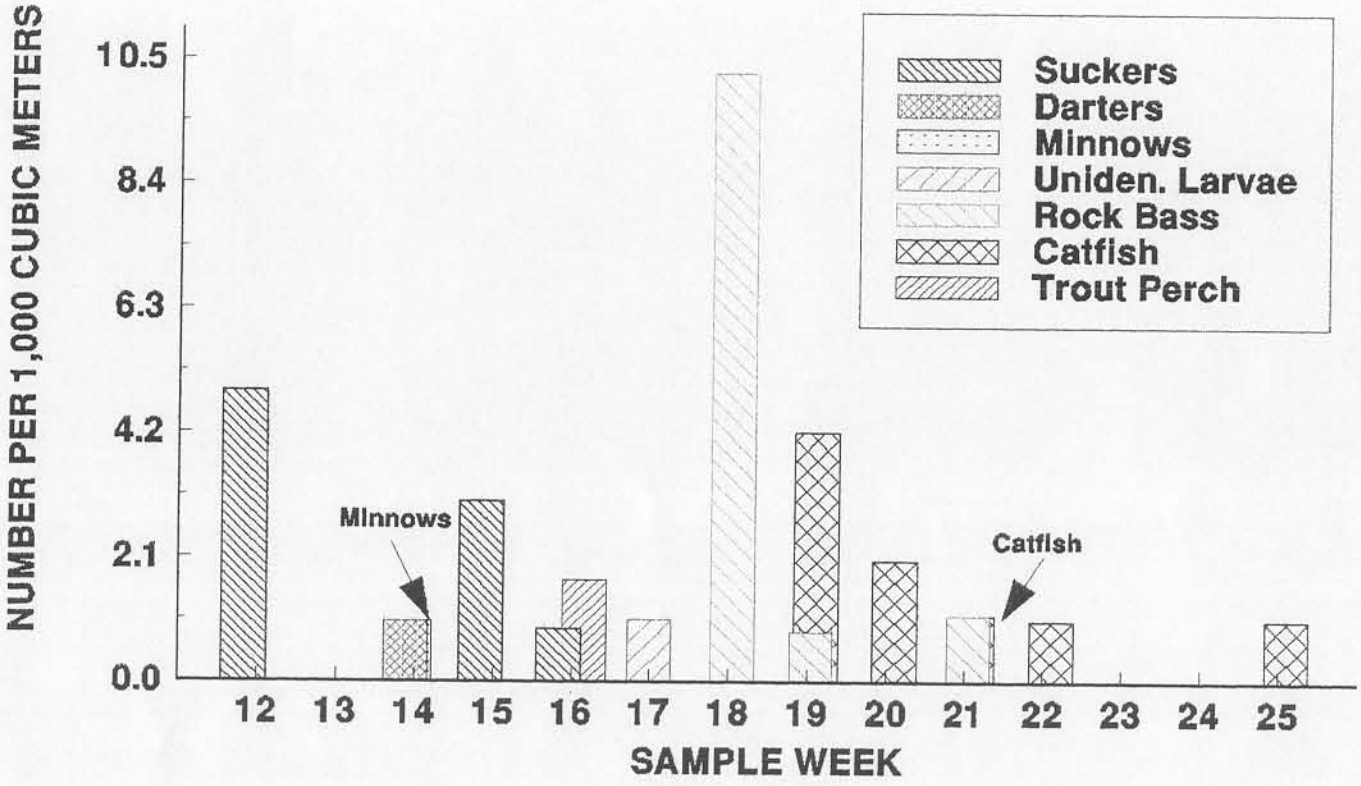

Figure 3-3. Weekly density of larval fish (#'s/1,000 cubic meters) in the intake cooling water at the Fort Drum HTW Cogeneration Facility during the 25-week study period (no larvae were found in weeks 1 through 11)

Table 3-1. Comparison of average monthly flows through the Fort Drum Cogeneration Facility in 1993 with average monthly flows in the Black River as measured at the USGS station in Watertown, New York (1989-1992)

Month	Average Monthly Flows in Black River (Million Gallons Per Minute)	Average Monthly Flow Through Facility During 1993 (gpm)	Percent of River Flow-by Withdrawn by the Facility
March	2.28	30,326	1.3
April	3.31	25,462	0.8
May	1.58	32,639	2.1
June	0.872	33,200	3.8
July	0.772	26,177	3.4
August	0.765	33,170	4.3

Table 3-2. Summary of species collected in entrainment samples during the 25-week study period at the Fort Drum Cogeneration Facility and the period of occurrence of each species

Family / Species	Total Number Collected in Entrainment Samples	Total Percent Composition %	Weeks of Occurrence
Suckers (Catostomidae)	9	25	12, 15,16
Sunfishes (Centrachidae) rock bass (Ambloplites rupestris)	12	33	18, 19, 21
Catfishes (Ictaluridae)	10	27	19, 20, 21, 22, 25
Minnows (Cyprinidae)	1	2.7	14
Darters (Percidae)	1	2.7	14
Trout-perches (Percopsidae) Trout-perch (Percopsis omiscomaycus)	2	6.9	16
Unidentified larvae (damaged)	1	2.7	17
TOTAL COLLECTED FROM PUMP HOUSE	**36**	100	

BLACK RIVER POWER, LLC

FORT DRUM POWER PLANT
P.O. BOX 330, FORT DRUM, NEW YORK 13603-0330

BUS.: (315) 773-2314
FAX: (315) 773-3416

Tetra Tech
C/o Kelley Meadows, Tetra Tech, Inc.
10306 Eaton Place, Suite 340
Fairfax, VA 22030

RE: Requested Larval Fish Entrainment Report

To Whom It May Concern:

As requested we have enclosed the Black River Power, LLC Larval Fish Entrainment Report.

If you have any further questions please call me at 315-773-2314.

Sincerely,

Steven McCall

Steven McCall
Plant Engineer

SM/dij

Enc

Two specimens of yolk-sac stage trout-perch (*Percopsis omiscomaycus*) were found in the 18 June collections (week 16). Trout-perch adults do not exceed 6 inches in length and possess an adipose fin, a fleshy lobe near the tail behind the spiney dorsal fin. According to Nancy Auer, the taxonomic specialist who verified the species identifications, this species which is commonly found in Canada and New York State has not been reported previously in the Black River.

All larvae collected were less than 14 mm long and all but the trout-perch were in post yolk-sac stage of development. Average length and the range of lengths of the fish larvae collected is presented in Table 3-3.

Estimates of total weekly entrainment based on the average weekly flows through the facility and species density suggested that 41,762 larvae were entrained through the facility during the 25-week study period. Estimated total entrainment of rock bass was highest (14,000), and most rock bass were entrained during week 18 (Fig. 3-4). Approximately 11,000 sucker larvae were entrained during the study period, and weekly total entrainment ranged from 6,000 during week 12 to as little as 1,100 during week 16. Between 9 July (week 19) and 20 August (week 25) more than 10,000 catfish larvae were entrained through the facility. Among the remaining species (minnows, darters, trout-perch, and unidentified larvae) an estimated total of 6,500 individuals were entrained.

In-river sampling produced only four larvae from the samples conducted on weeks 13, 14, and 16, suggesting that larval populations near the facility's intake are low (Table 3-4). Sucker and minnow larvae (*Notropis sp.*) were found in these collections, ranging in density from 4 and to about 1 larvae per 1,000 cubic meters, respectively.

Table 3-3. Average length and range of lengths of larval fish collected in entrainment samples during the 25-week study period at the Fort Drum Cogeneration Facility

Family/Species	Mean Length (mm)	Length Range (mm)
Suckers (Catostomidae)	12.5	10-13.5
Sunfishes (Centrachidae) rock bass (*Ambloplites rupestris*)	8	7-10
Catfishes (Ictaluridae)	13.5	8-15
Minnows (Cyprinidae)	5	--
Darters (Percidae)	6	--
Trout-perches (Percopsidae) Trout-perch (*Percopsis omiscomaycus*)	4.8	4.5-5
Unidentified larvae (damaged)	5	--
TOTAL COLLECTED FROM PUMP HOUSE	**36**	100

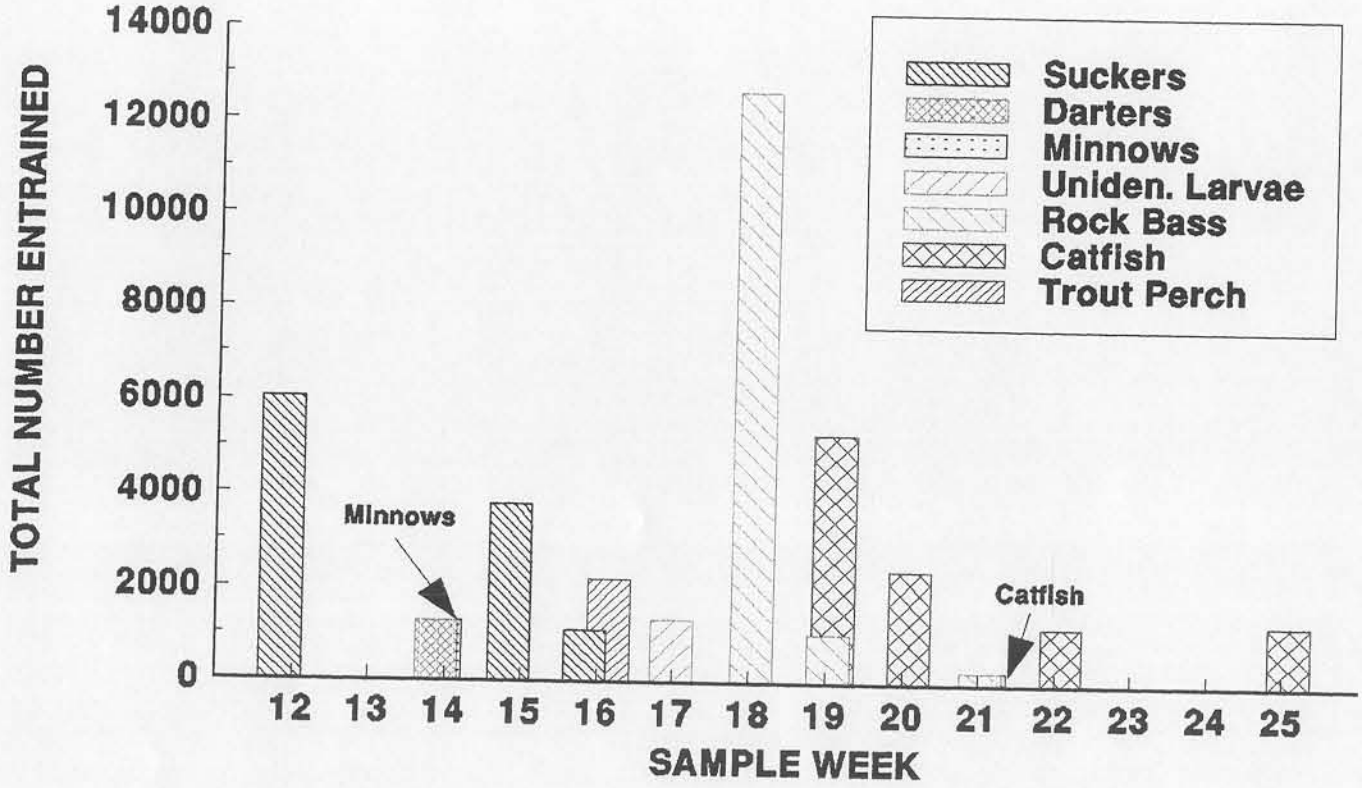

Figure 3-4. Estimated weekly total larval fish entrainment at the Fort Drum HTW Cogeneration Facility during the 25-week study period (no larvae were found in weeks 1 through 11)

Table 3-4. Summary of catches of larvae in samples collected in the Black River between weeks 10 and 25

Sample Week (Date)	Species	Density (Numbers per 1,000 cubic meters)	Number collected
13 (28 May)	White sucker (*Catostomus commersoni*)	1.15	1
14 (4 June)	Cyprinidae (*Notropis sp.*)	1.01	1
16 (18 June)	unidentified sucker (Catostomidae)	4.0	2

4.0 SUMMARY

The total entrainment rate at the Fort Drum HTW Cogeneration Facility is extremely low; only 36 larvae were collected in more than 10.5 million gallons of water filtered during the 25-week entrainment study. The low entrainment rate probably resulted from both the protection from entrainment afforded by the 3-mm wedge-wire screens and the low larval densities in the river. Although the in-river sampling from the downstream bridge was not comprehensive enough to accurately describe the distribution and abundance of larvae in the Black River (this element of the study was added to provide a qualitative evaluation of populations in the river), the low catches suggests that the portion of the Black River near the intake is not an important spawning area. Low fish populations in the area near the intake are supported by anecdotal information received from local fishermen, who indicated that recreational fishing in this section of the river is not extensive. In addition, the presence of at least eight downstream dams further limits the importance of the area for fish communities because species from Lake Ontario are blocked from migrating to the Fort Drum area.

Although estimates of total weekly entrainment indicate that as many as 41,000 larvae were entrained through the facility between the months of March and August 1993, this number is small relative to the number of eggs typical female fish lays in a spawning season. For example, one female white sucker releases an average of 50,000 eggs; catfish and rock bass females lay about 9,000 and 8,500 eggs, respectively (Carlander 1970; Auer 1982). Given the fecundity of the major species in the Black River, and ignoring the effects of natural mortality, the cogeneration facility entrained the equivalent of one fifth of the spawn from one female white sucker and the entire spawn of one catfish and two rock bass females.

5.0 REFERENCES

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Auer, N.C. 1982. Identification of larval fishes of the Great Lakes Basin with emphasis on the Lake Michigan drainage. Special Publication 82-3. Great Lakes Fishery Commission. Ann Arbor, Michigan.

Smith, C.L. 1985. The inland fishes of New York State. The New York State Department of Environmental Conservation.

USGS 1988. Water Resources Data, New York, Water Year 1988. Prepared by the Water Resources Division, U.S. Geological Survey, Albany, New York.

APPENDIX A

FORT DRUM FLOW DATA

FORT DRUM FLOW DATA

WEEK	DATE	DAILY AVERAGE FLOW RATE (GPM)	AVERAGE WEEKLY FLOW RATE (GPM)	MONTHLY AVERAGE FLOW RATE (GPM)
1	03/01/93	29,370		
	03/02/93	29,108		
	03/03/93	29,300		
	03/04/93	30,000		
	03/05/93	30,910		
	03/06/93	30,970		
	03/07/93	30,940	30085.43	
2	03/08/93	30,890		
	03/09/93	30,870		
	03/10/93	30,760		
	03/11/93	30,720		
	03/12/93	30,450		
	03/13/93	30,720		
	03/14/93	30,950	30765.71	
3	03/15/93	30,770		
	03/16/93	30,630		
	03/17/93	28,500		
	03/18/93	29,090		
	03/19/93	29,170		
	03/20/93	29,470		
	03/21/93	29,590	29602.86	
4	03/22/93	29,950		
	03/23/93	29,960		
	03/24/93	30,500		
	03/25/93	30,650		
	03/26/93	30,910		
	03/27/93	30,910		
	03/28/93	30,940	30545.71	
5	03/29/93	31,130		
	03/30/93	31,150		
	03/31/93	30,830		30326.0
	04/01/93	30,670		
	04/02/93	30,650		
	04/03/93	30,530		
	04/04/93	30,200	30737.14	
6	04/05/93	30,200		
	04/06/93	24,380		
	04/07/93	21,220		
	04/08/93	26,290		
	04/09/93	30,990		
	04/10/93	29,420		
	04/11/93	15,600	25442.86	

FORT DRUM FLOW DATA

WEEK	DATE	DAILY AVERAGE FLOW RATE (GPM)	AVERAGE WEEKLY FLOW RATE (GPM)	MONTHLY AVERAGE FLOW RATE (GPM)
7	04/12/93	23,860		
	04/13/93	26,140		
	04/14/93	21,960		
	04/15/93	19,440		
	04/16/93	19,130		
	04/17/93	18,270		
	04/18/93	20,280	21297.14	
8	04/19/93	25,520		
	04/20/93	27,010		
	04/21/93	18,080		
	04/22/93	25,530		
	04/23/93	27,640		
	04/24/93	24,590		
	04/25/93	27,470	25120.00	
9	04/26/93	27,860		
	04/27/93	27,810		
	04/28/93	27,770		
	04/29/93	27,660		
	04/30/93	27,700		25462.33
	05/01/93	30,390		
	05/02/93	33,520	28958.57	
10	05/03/93	32,780		
	05/04/93	33,530		
	05/05/93	33,510		
	05/06/93	32,710		
	05/07/93	32,760		
	05/08/93	33,180		
	05/09/93	33,530	33142.86	
11	05/10/93	32,690		
	05/11/93	32,030		
	05/12/93	31,920		
	05/13/93	32,900		
	05/14/93	33,270		
	05/15/93	33,350		
	05/16/93	33,610	32824.29	
12	05/17/93	33,090		
	05/18/93	32,360		
	05/19/93	32,390		
	05/20/93	32,370		
	05/21/93	32,180		
	05/22/93	32,140		
	05/23/93	31,890	32345.71	

FORT DRUM FLOW DATA

WEEK	DATE	DAILY AVERAGE FLOW RATE (GPM)	AVERAGE WEEKLY FLOW RATE (GPM)	MONTHLY AVERAGE FLOW RATE (GPM)
13	05/24/93	32,150		
	05/25/93	31,790		
	05/26/93	31,720		
	05/27/93	32,890		
	05/28/93	32,340		
	05/29/93	32,800		
	05/30/93	32,860	32364.29	
14	05/31/93	33,160		32639.03
	06/01/93	33,370		
	06/02/93	33,310		
	06/03/93	33,100		
	06/04/93	33,030		
	06/05/93	33,980		
	06/06/93	32,920	33124.29	
15	06/07/93	32,640		
	06/08/93	29,020		
	06/09/93	31,330		
	06/10/93	33,280		
	06/11/93	33,430		
	06/12/93	33,540		
	06/13/93	33,660	32414.29	
16	06/14/93	33,680		
	06/15/93	33,660		
	06/16/93	33,800		
	06/17/93	33,960		
	06/18/93	33,880		
	06/19/93	33,790		
	06/20/93	33,740	33787.14	
17	06/21/93	33,960		
	06/22/93	34,200		
	06/23/93	33,840		
	06/24/93	33,550		
	06/25/93	33,420		
	06/26/93	33,720		
	06/27/93	33,890	33797.14	
18	06/28/93	32,040		
	06/29/93	32,640		
	06/30/93	32,620		33200
	07/01/93	32,690		
	07/02/93	32,080		
	07/03/93	32,220		
	07/04/93	32,250	32362.86	

FORT DRUM FLOW DATA

WEEK	DATE	DAILY AVERAGE FLOW RATE (GPM)	AVERAGE WEEKLY FLOW RATE (GPM)	MONTHLY AVERAGE FLOW RATE (GPM)
19	07/05/93	32,570		
	07/06/93	31,990		
	07/07/93	31,890		
	07/08/93	33,210		
	07/09/93	33,780		
	07/10/93	33,850		
	07/11/93	33,790	33011.43	
20	07/12/93	33,780		
	07/13/93	33,680		
	07/14/93	33,660		
	07/15/93	33,660		
	07/16/93	33,600		
	07/17/93	33,530		
	07/18/93	14,960	30981.43	
21	07/19/93	6,720		
	07/20/93	6,580		
	07/21/93	5,940		
	07/22/93	3,450		
	07/23/93	3,210		
	07/24/93	3,500		
	07/25/93	15,460	6408.571	
22	07/26/93	27,870		
	07/27/93	31,010		
	07/28/93	31,170		
	07/29/93	32,900		
	07/30/93	33,350		
	07/31/93	33,160		26177.74
	08/01/93	32,810	31752.86	
23	08/02/93	32,680		
	08/03/93	36,200		
	08/04/93	32,550		
	08/05/93	32,530		
	08/06/93	32,660		
	08/07/93	32,760		
	08/08/93	32,560	33134.29	
24	08/09/93	32,400		
	08/10/93	33,300		
	08/11/93	32,000		
	08/12/93	32,940		
	08/13/93	32,900		
	08/14/93	33,310		
	08/15/93	33,550	32914.29	
25	08/16/93	33,590		
	08/17/93	33,430		
	08/18/93	33,510		
	08/19/93	33,520		
	08/20/93	33,520		
	08/21/93	33,520		
	08/22/93	33,520	33515.71	33170.91

APPENDIX B

FORT DRUM ENTRAINMENT SAMPLING DATA

FORT DRUM ENTRAINMENT SAMPLING DATA

WEEK	DATE	NUMBER OF CIRCULATORS	HEAD HEIGHT	SHIFT	TEMP	DO	PH
1	03/06/93	3	17′ 0"	1	0.8	-	7.3
	03/06/93	3	16′ 4"	2	0.9	-	7.3
	03/06/93	3	17′ 0"	3	1.0	16.0	7.3
	03/05/93	3	16′ 0"	4	1.0	-	6.7
	03/05/93	3	16′ 1"	5	1.0	-	6.7
	03/05/93	3	16′ 2"	6	0.8	-	7.0
2	03/13/93	3	16′ 2"	1	3.2	16.4	6.6
	03/13/93	3	16′ 0"	2	3.5	15.9	6.8
	03/13/93	3	16′ 0"	3	3.5	16.8	6.8
	03/13/93	3	16′ 1"	4	3.0	15.6	6.4
	03/12/93	3	16′ 0"	5	3.5	15.8	6.2
	03/12/93	3	16′ 3"	6	3.1	16.2	6.3
3	03/19/93	3	16′ 1"	1	3.1	16.2	6.8
	03/20/93	3	16′ 1"	2	2.5	16.1	6.8
	03/20/93	3	15′ 11"	3	4.0	15.9	6.7
	03/20/93	3	16′ 0"	4	3.0	15.6	6.7
	03/19/93	3	16′ 1"	5	3.0	15.6	6.2
	03/19/93	3	16′ 0"	6	3.0	16.1	6.8
4	03/27/93	3	16′ 4"	1	3.0	17.4	6.9
	03/27/93	3	16′ 3"	2	2.5	17.0	6.8
	03/27/93	3	16′ 3"	3	2.0	17.1	6.8
	03/27/93	3	16′ 3"	4	3.0	17.2	7.0
	03/26/93	3	16′ 3"	5	3.5	15.8	6.8
	03/26/93	3	16′ 3"	6	3.5	16.3	6.9
5	04/03/93	3	15′ 11"	1	2.0	16.1	6.6
	04/03/93	3	15′ 7"	2	1.8	15.9	6.8
	04/03/93	3	15′ 2"	3	2.8	15.3	6.8
	04/03/93	3	15′ 10"	4	2.0	15.2	6.9
	04/02/93	3	17′ 6"	5	2.0	15.9	6.5
	04/02/93	3	15′ 11"	6	2.0	16.0	7.0
6	04/10/93	3	16′ 3"	1	5.2	16.0	7.1
	04/10/93	3	16′ 2"	2	5.4	16.2	6.4
	04/10/93	3	15′ 5"	3	5.2	16.0	6.8
	04/10/93	3	16′ 5"	4	6.0	16.0	7.1
	04/09/93	3	16′ 3"	5	6.1	13.4	7.0
	04/09/93	3	15′ 8"	6	6.1	13.6	7.0
7	04/17/93	2	17′ 8"	1	8.3	13.2	7.1
	04/17/93	2	17′ 8"	2	8.2	13.8	6.5
	04/17/93	2	17′ 6"	3	8.0	13.0	6.9
	04/17/93	2	17′ 3"	4	8.0	12.9	6.9
	04/16/93	2	17′ 10"	5	8.0	16.2	7.0
	04/17/93	2	17′ 8"	6	8.3	12.8	7.0

FORT DRUM ENTRAINMENT SAMPLING DATA

WEEK	DATE	NUMBER CIRCULATOR	HEAD HEIGHT	SHIFT	TEMP	DO	PH
8	04/24/93	3	20′ 7"	1	6.5	14.5	6.4
	04/24/93	3	20′ 5"	2	5.8	14.0	6.9
	04/24/93	3	20′ 5"	3	5.0	13.2	6.8
	04/24/93	3	20′ 5"	4	5.9	13.2	6.8
	04/23/93	3	20′ 7"	5	5.0	13.1	6.5
	04/23/93	3	20′ 9"	6	5.0	13.1	7.1
9	04/30/93	3	22′ 5"	1	10.2	12.0	6.7
	05/01/93	3	22′ 9"	2	10.3	12.2	6.2
	05/01/93	4	16′ 0"	3	10.5	11.6	6.8
	05/01/93	4	16′ 7"	4	11.0	12.0	6.8
	04/30/93	3	22′ 5"	5	11.0	16.9	6.1
	04/30/93	3	22′ 5"	6	11.0	12.9	6.7
10	05/07/93	4	17′ 8"	1	15.0	9.8	7.0
	05/08/93	4	17′ 7"	2	14.5	11.6	7.0
	05/08/93	4	17′ 6"	3	14.5	10.5	7.0
	05/08/93	4	17′ 7"	4	15.1	10.6	7.1
	05/07/93	4	17′ 8"	5	15.2	10.5	7.0
	05/07/93	4	17′ 8"	6	15.4	9.5	6.9
11	05/14/93	4	18′ 0"	1	16.0	9.8	6.8
	05/14/93	4	18′ 0"	2	16.0	9.9	6.8
	05/14/93	4	18′ 6"	3	15.9	9.9	6.8
	05/14/93	4	18′ 8"	4	15.9	9.7	6.9
	05/14/93	4	18′ 3"	5	16.5	9.8	6.7
	05/14/93	4	18′ 4"	6	17.0	10.5	7.0
12	05/22/93	4	18′ 5"	1	15.0	9.8	6.7
	05/22/93	4	18′ 6"	2	15.0	10.0	6.6
	05/22/93	4	18′ 6"	3	15.0	10.2	6.8
	05/22/93	4	18′ 5"	4	15.0	10.0	7.1
	05/21/93	4	18′ 6"	5	15.0	10.4	6.7
	05/21/93	4	18′ 9"	6	14.8	10.4	6.6
13	05/29/93	4	18′ 10"	1	14.1	9.8	7.0
	05/29/93	4	18′ 8"	2	14.0	9.6	7.0
	05/29/93	4	18′ 7"	3	13.9	9.8	7.1
	05/29/93	4	18′ 7"	4	14.0	10.0	7.0
	05/28/93	4	18′ 6"	5	15.0	11.2	7.0
	05/28/93	4	18′ 5"	6	14.9	9.8	7.1
14	06/05/93	4	18′ 10"	1	15.0	9.9	7.2
	06/05/93	4	18′ 6"	2	15.0	10.0	7.2
	06/05/93	4	18′ 9"	3	14.9	9.8	6.4
	06/05/93	4	18′ 3"	4	15.0	10.0	6.5
	06/04/93	4	18′ 2"	5	15.3	9.8	7.1
	06/04/93	4	18′ 3"	6	15.0	10.2	7.0

FORT DRUM ENTRAINMENT SAMPLING DATA

WEEK	DATE	NUMBER CIRCULATOR	HEAD HEIGHT	SHIFT	TEMP	DO	PH
15	06/12/93	4	18′ 7"	1	18.0	9.5	7.0
	06/12/93	4	18′ 9"	2	18.0	9.5	6.9
	06/12/93	4	18′ 5"	3	17.5	10.8	7.0
	06/12/93	4	18′ 5"	4	19.0	9.8	7.1
	06/11/93	4	17′ 11"	5	17.5	9.4	6.5
	06/11/93	4	18′ 5"	6	18.0	9.7	6.6
16	06/19/93	4	18′ 5"	1	20.0	9.8	7.0
	06/18/93	4	18′ 5"	2	20.0	9.8	6.9
	06/19/93	4	18′ 5"	3	20.0	9.2	7.0
	06/19/93	4	18′ 5"	4	20.0	9.2	7.0
	06/18/93	4	18′ 5"	5	20.0	8.9	6.7
	06/18/93	4	18′ 8"	6	20.0	9.1	6.7
17	06/26/93	4	18′ 0"	1	21.0	8.7	7.1
	06/23/93	4	18′ 0"	2	22.0	8.5	7.0
	06/26/93	4	17′ 10"	3	20.8	9.1	6.9
	06/26/93	4	18′ 0"	4	21.0	9.2	6.9
	06/25/93	4	17′ 11"	5	21.2	8.6	6.5
	06/25/93	4	18′ 2"	6	22.0	8.8	7.0
18	07/03/93	4	18′ 11"	1	21.1	9.2	8.7
	07/03/93	4	18′ 11"	2	21.0	9.0	5.7
	07/03/93	4	18′ 10"	3	21.0	9.1	6.1
	07/03/93	4	18′ 11"	4	21.1	9.1	5.9
	07/02/93	4	18′ 11"	5	21.4	8.2	6.7
	07/02/93	4	18′ 11"	6	21.4	8.2	9.1
19	07/09/93	4	17′ 11"	1	27.0	8.8	6.2
	07/10/93	4	18′ 0"	2	27.2	9.0	6.3
	07/10/93	4	18′ 1"	3	27.2	8.1	6.0
	07/10/93	4	18′ 1"	4	27.4	9.6	5.8
	07/09/93	4	17′ 10"	5	26.8	9.2	6.5
	07/09/93	4	18′ 1"	6	27.2	8.5	6.0
20	07/17/93	4	18′ 4"	1	24.7	8.7	7.1
	07/17/93	4	18′ 4"	2	24.9	8.8	7.1
	07/17/93	4	18′ 3"	3	23.2	9.1	8.5
	07/17/93	4	18′ 4"	4	24.8	9.0	7.2
	07/16/93	4	18′ 5"	5	25.1	8.5	6.1
	07/16/93	4	18′ 3"	6	25.1	9.0	6.2
21	07/24/93	1	23′ 8"	1	21.5	8.1	6.6
	07/24/93	1	23′ 7"	2	22.0	8.3	6.0
	07/24/93	1	24′ 2"	3	21.3	7.6	7.0
	07/24/93	1	23′ 6"	4	22.5	-	6.8
	07/23/93	1	23′ 6"	5	22.0	7.8	6.4
	07/23/93	1	23′ 6"	6	21.8	7.8	6.6

FORT DRUM ENTRAINMENT SAMPLING DATA

WEEK	DATE	NUMBER CIRCULATOR	HEAD HEIGHT	SHIFT	TEMP	DO	PH
22	07/31/93	4	25′ 6"	1	23.2	9.5	7.0
	07/31/93	4	25′ 6"	2	23.5	9.3	7.0
	07/31/93	4	25′ 6"	3	24.0	9.5	7.0
	07/31/93	4	25′ 2"	4	24.0	9.8	6.8
	07/30/93	4	24′ 1"	5	23.6	9.2	8.6
	07/30/93	4	24′ 0"	6	23.2	9.2	7.4
23	08/07/93	4	16′ 8"	1	22.8	8.8	7.0
	08/07/93	4	25′ 0"	2	22.2	8.0	6.9
	08/07/93	4	25′ 0"	3	23.6	8.8	6.6
	08/07/93	4	25′ 0"	4	22.0	9.4	7.0
	08/06/93	4	17′ 0"	5	23.1	8.2	6.7
	08/06/93	4	17′ 1"	6	23.5	8.6	6.8
24	08/13/93	4	25′ 0"	1	23.1	10.7	6.2
	08/14/93	4	25′ 0"	2	22.8	9.6	7.8
	08/14/93	4	25′ 0"	3	23.0	9.8	7.3
	08/14/93	4	25′ 0"	4	24.0	8.3	7.3
	08/13/93	4	25′ 0"	5	23.9	11.2	6.2
	08/13/93	4	25′ 0"	6	23.0	10.8	6.2
25	08/21/93	4	25′ 0"	1	23.0	9.8	-
	08/21/93	4	25′ 0"	2	23.0	9.9	-
	08/21/93	4	25′ 0"	3	24.0	9.4	7.0
	08/21/93	4	25′ 0"	4	24.3	9.3	7.0
	08/20/93	4	25′ 0"	5	23.0	9.8	9.3
	08/20/93	4	25′ 0"	6	23.2	9.6	7.0